XVII. *The Natural History, Anatomy, and Development of* Meloë (*continued*).

By George Newport, *Esq., F.R.S., F.L.S. &c. &c.*

Second Memoir.

The History and General Anatomy of Meloë, *and its Affinities, compared with those of the* Strepsiptera *and* Anoplura, *with reference to the connexion which exists between Structure, Function, and Instinct.*

Read January 19th, 1847.

In the memoir on *Meloë* which I had the honour of communicating to this Society in November 1845, I endeavoured to trace the natural history of the genus. Hereafter I propose to enter fully on the anatomy of the species, in the larva, nymph, and imago states, and to compare it, so far as we are able, with that of allied genera.

On the present occasion, before entering on the details of special structure, I shall endeavour to show that structure and instinct are closely associated; that the whole of those groups of insects which are most nearly allied to the Meloës in general organization are also very similar to them in their habits and economy; and that, in their larva state, they have many analogies with the *Anoplura*, and with the *Strepsiptera*, the history of which I shall trace, to compare with that of *Meloë*. In those insects in which the general form of body, or of any important organ, is markedly different from the type we are considering, we always find that there are corresponding differences in the economy of the species. When the entire organism of a structure is modified, then the functions of that structure, and the habits of the species associated with it, are in some respects completely changed. But when a structure is simply hypertrophied, or atrophied, then that particular instinct, of which it is the agent, continues to be more or less strongly characteristic of the animal.

This law of accordance between structure and function is universal through-

out the organized world; and it is especially marked in the whole of the hexapod *Articulata*. I shall attempt to exemplify its prevalence, and to show the connexion of particular instincts with peculiarities of structure, by comparing the general anatomy of the Meloës with the facts of their natural history, and these with corresponding facts of structure and habit in other insects.

In this way applied, the truths of natural history may be rendered invaluable to science, as data on which a correct knowledge of the laws of creation and life may be established. I would thus attempt to bring our acquaintance with the habits of species, when compared with their organization, to help us to understand the nature of Instinct; as I have heretofore* endeavoured to apply the laws of physiology to aid us in understanding the comparative anatomy of the nervous system of the *Articulata*, and, through this, to assist in explaining that of our own bodies. Natural history, which has often been regarded as little other than merely a pleasing pursuit, may thus be made to occupy its proper position as an important branch of useful knowledge, and mainly help to demonstrate the connexion which subsists between structure and function, and function and the instincts of animals.

Of the Larva.

We have seen in the former memoir that the larvæ of the Meloës are active little hexapods, of very diminutive size, and that they attach themselves parasitically to the bodies of other insects, chiefly *Hymenoptera*. This remarkable fact in the economy of the tribe is one of the greatest importance, not only with reference to the development of these insects, but also to that of the whole of the *Articulata*, in connexion with the general laws of organization; since there are still naturalists who cling to the opinion, that the diminutive hexapods found on the bodies of the *Hymenoptera* are not the young of *Meloë*, but are adult parasitic forms. Leon Dufour, as we have seen, in 1828, even described them as a distinct genus, by the name of *Triungulinus*, and arranged them with the *Pediculi*†. Mr. Westwood ‡, ten years afterwards, adopted the same view, which he has not hitherto repudiated; and the same has again

* Phil. Trans. 1832, 1834, 1843. Todd's Cyclop. Anatom. and Physiology, Art. "Insecta," 1839.

† Annales des Scien. Nat. 1828.

‡ Introduction, &c. vol. i. 1839, p. 303.

been advanced, so recently as 1844, by M. Gervais*. This error has arisen from these able naturalists entirely overlooking the principles of development, and from their being misled by the great similarity of structure which exists between these young Meloës and the adult parasites of vertebrated animals, the *Pediculi* and *Nirmi*. These parasitic *Aptera*, properly regarded, are inferior or larval types of *Articulata*, in which organization is not carried beyond that stage at which the *Meloë* escapes from the egg, and are not essential, or true imago insect forms.

It is necessary therefore that we should first show to what species and genera of true insects this parasitic type of organization in the larva state belongs, and then endeavour to ascertain what general relations its peculiarities of structure bear, in whole or in part, to the habits of the individual species. This form of larva is not restricted to the genus *Meloë*. The larva of the common blister-fly, *Lytta vesicatoria*, as most accurately figured by Brandt†, is almost identical in form with that of *Meloë*, the chief structural difference being that *Lytta* has only one instead of two pairs of caudal setæ. *Lytta* however differs in colour. When it comes from the egg it is at first yellow, like *Meloë*, but quickly assumes a darker hue, and soon afterwards a deep black, excepting only on the first abdominal, and the meso- and metathoracic segments, which are yellow, with a dark patch on each side of the two latter. The larvæ of *Meloë cicatricosus*, *M. proscarabæus* and *M. violaceus* never acquire this darkened colour, but are always of a yellow or light orange. The larva found by Mr. Kirby on *Andrena fuscata*, and described by him as *Pediculus Melittæ*‡, and by myself on *Osmia spinulosa*, resembled the yellow larvæ of *Meloë* in almost every particular excepting in colour; and Mr. F. Smith, to whom I have referred in my former paper, has, as I have there stated, taken similar black larvæ in great profusion on the *Andrenidæ*, especially on *Andrena fuscata*, captured in the spring on Hampstead Heath, where different species of the adult Meloës are often abundant. In April 1841 he found similar black larvæ in such profusion within the flowers of the buttercup

* Nouv. Suites à Buffon, Aptères, tome iii. 1844, p. 360.

† Brandt und Ratzeburg, Darstell. und Beschr. der Thiere, Berlin, p. 129, pl. 19.

‡ Monographia Apum Angl. vol. ii. p. 168.

(*Ranunculus acris*, L.), in a damp field at Bishop's wood, Hampstead, that he might have collected thousands of them, there being often as many as twenty specimens in the corolla of a single flower*. But he never found a yellow-coloured specimen on any of the *Andrenidæ*. Like myself, he has taken the yellow-coloured ones on *Volucella*, the dipterous parasite of the nests of *Bombi*; on the *Nomadæ*, themselves parasitic on other bees, chiefly *Eucera*, *Andrena* and *Colletes*†, and also on the *Halicti*. It was on these genera that yellow-coloured larvæ were found by Gœdart‡, Frisch§, Reaumur‖, DeGeer¶, Walckenaer** and De Tigny††. Latreille‡‡, when speaking of those described by DeGeer, says, that he has himself many times met with these larvæ crowded together on grass; at the roots of which, as I have already shown, the *Meloë* always deposits her eggs, and the young, quickly after they are hatched, ascend from thence into the flowers of the *Ranunculus* and *Taraxacum*, in which I have myself detected them.

On examining the *black-coloured* specimens, which Mr. Smith obtained from the *Andrenidæ*, I have found that they are perfectly distinct from those which I know are produced from the eggs of the three species of *Meloë* already mentioned. They are of larger size, and are of a deep jet-black colour, excepting only the legs, which are dark testaceous. Thus they are identical in character with the supposed *Pediculus Melittæ*, taken by Mr. Kirby also on *Andrena*. They approach closely in general appearance to the yellow specimens found on *Nomada*, which I am satisfied are the young of some species of *Meloë*. They have a similar general form of body, and the same number of segments and of caudal setæ, the exterior pair of which are the shortest. They both have large and powerful thighs, long convex tibiæ, and long claw-like tarsi, each formed of three digitations, of which the middle digitation only

* Trans. Ent. Soc. Lond. vol. iii. p. 294.

† Trans. Ent. Soc. vol. iii. part 4. p. 294. I have taken *Nomada Sheppardana* in the nest of *Colletes*, and Mr. Smith has taken other *Nomadæ* in those of *Eucera*, *Andrena* and *Colletes* (see Trans. Ent. Soc. vol. iii. p. 293, 1843; and Zoologist, June 1844, pp. 587–606).

‡ Mémoires Nat. Hist. Ins. t. ii. p. 180.

§ Insecten, fasc. vi. p. 15.

‖ Mémoires, tome iv. p. 490.

¶ Mémoires, tome v. p. 8.

** Mém. sur le gen. Halictus, 1817, p. 85.

†† Hist. Ins. tome vii. p. 647.

‡‡ Hist. Nat. des Crust. et des Ins. t. x. p. 380.

represents the true tarsus, and the lateral elongated tarsal spines, the whole being equally strong, very acute, and spear-shaped. But they differ in the head being more produced anteriorly, and in the prothorax being more elongated and quadrangular in the specimens from the *Nomadæ* than in those from the *Andrenidæ*. Both also differ slightly from specimens which I have reared from the eggs of *Meloë cicatricosus* and *Meloë violaceus*. In the latter species the head is almost semicircular, the prothorax is rounded behind, broader than long, and much wider than the meso- and meta-thoracic segments; while the abdominal segments are more pubescent, and have each a pair of short hairs at the sides, corresponding to the caudal setæ of the præanal segment. In all other respects of structure, the specimens found on *Nomadæ* are similar to those bred from the eggs of *M. violaceus*, so that they may fairly be regarded as the young of a species of *Meloë*. They occur of two sizes on the *Nomadæ*, but these are identical in structure. This leads me to the conclusion, in opposition to the opinion often advanced by others, that the larvæ grow slightly while on the bodies of the bees, before they are conveyed to the nests. Most certainly I have noticed a slight increase in size in specimens bred by myself from the eggs of *Meloë cicatricosus*.

Baron Walckenaer*, who doubted that the parasites found on *Hymenoptera* are the young of *Meloë*, obtained a yellow-coloured specimen from *Halictus Elephas*, which differed from all others hitherto described in having the caudal setæ only of a black colour, with the exterior pair instead of the interior the longest. These characters convince me that this was a distinct species, although that learned naturalist regarded it only as a variety of the species already described. Whether the specimen found by Leon Dufour† on *Andrena* was similar to Mr. Kirby's species is not certain. From the statement that it was furnished with *one* pair of caudal setæ, there is reason to believe that it was different. The second pair of setæ might perhaps, however, have been overlooked, as in those found by Mr. Smith, which are identical with Mr. Kirby's, the exterior pair of setæ are exceedingly short and slender. Whether the black-coloured larvæ are in reality the young of any species of *Meloë*, or

* Mémoires pour servir à l'Histoire naturelle des Abeilles solitaires qui composent le genre Halicte, 1817, 8vo, pp. 85, 86.

† Ann. des Sci. Nat. 1828.

whether they belong to some other allied genus, remains for future investigation. I have no doubt that the whole of the hitherto-described yellow specimens found on *Hymenoptera* and *Diptera* are the young of true Meloës. The different species of *Meloë* probably are peculiar to distinct species of *Hymenoptera*; as it will be remembered that, in the experiments detailed in my former memoir*, I could not succeed in rearing the larvæ of *Meloë proscarabæus* or *Meloë violaceus* in the nests of *Anthophora retusa*, although I obtained numerous full-grown larvæ, nymphs and imagos of *Meloë cicatricosus* from the nests of *Anthophora* in its natural haunts.

Since the reading of that memoir, Mr. Smith has obtained a specimen of *Meloë abdominalis*, Kirby, MSS.†, in the immature imago state, from the nest of *Saropoda* or of *Colletes*, in a bank thickly crowded with the nidi of these bees. The specimen had very recently changed from the nymph to the imago, and was still almost colourless, soft, and exceedingly delicate. In the course of a few weeks it gradually acquired the natural intense blue-black hue of the species, and its teguments became hardened. In the month of March it was capable of locomotion, and moved about vigorously. It was a male individual, and is now in Mr. Smith's cabinet.

Thus then there is good reason to believe that all the Meloës are parasitic on the *Hymenoptera*. The genera allied to them appear also to have similar habits. M. Gondot‡ found both sexes of *Tetraonyx flavipennis*, a species recently described by M. Guerin Meneville, *in coitu*, crawling slowly on the ground, near large stones, in the temperate region of the Cordilleras in Columbia, in places frequented by *Bombi*, in the nests of which he believes the larvæ of *Tetraonyx* reside. *Mylabris*, according to Dr. Gebler§, deposits its eggs in the earth in the western parts of Siberia, on the borders of Tartary, where scarcely any trees, and very few shrubs exist. The larvæ,

* Pages 315, 316.

† On examining Mr. Kirby's specimens in the Cabinet of the Entomological Society, both Mr. Smith and myself are of opinion that the two specimens under this name are only very diminutive varieties of *M. proscarabæus*.

‡ Magazin de Zool. 1844, Ins. tab. 141.

§ Des Mylabrides de la Sibérie occidentale des confins de la Tartarie; Nouv. Mém. de la Soc. Imp. des Nat. de Moscou, tome vii. 1829.

Dr. Gebler states, reside in the ground, probably in the nests of some *Hymenoptera*. M. Gené* has shown that the eggs and larvæ of *Apalus bimaculatus* closely resemble those of *Meloë*, and that they are precisely similar in form and habit to the so-called *Triungulinus Andrenetarum* of Dufour. M. Gené however was unable to trace the growth of these larvæ, probably from causes similar to those which have hitherto prevented our tracing the early stages of growth in *Meloë*. The larva of *Sitaris* also, according to the figure given by Mr. Westwood†, resembles that of *Meloë* in some of its characters, and apparently also in its kind of parasitism. MM. Audouin and Pecchioli‡ found the eggs of *Sitaris Solieri*, with the larvæ within them almost ready to burst their envelopes, deposited in great abundance, in a white glutinous material, on the flowers of the rosemary, in the neighbourhood of Pisa; besides a great number of larvæ on the ground, which had recently come forth, but which they were unable to follow through their changes. The eggs closely resembled those of *Sitaris humeralis*, which insect M. Audouin had seen deposit her ova, and from which ova the larvæ delineated by the naturalist above-mentioned were obtained. M. Audouin also had found the perfect insect in the nest of an *Anthophora*. *Sitaris humeralis* seems to have been taken in this country formerly by Mr. Kirby, as there are three specimens in the Kirbian collection. A few years since it was found by the Rev. Mr. Badger§ in some abundance on a wall at Chelsea in the month of September. In that month also, in 1841, it was taken by Mr. S. Stevens‖, on the wall of his garden at Hammersmith; and it was at that period of the year that M. Pecchioli¶ found both sexes of *Sitaris Solieri* at Pisa, *in coitu*, in great abundance on the wild rosemary. M. Pecchioli met with this species at two distant periods, and in different localities, but always on the same kind of plant. M. Rambuhr** also found many specimens of *Sitaris* in the cells of *Hymenoptera*, in dry ground, exposed to a northern rather than to a southern aspect. From these facts it appears cer-

* Westwood's Introduction, vol. i. p. 299.

† *Ibid*, p. 294. fig. 34. No. 4, 5.

‡ Annales de la Soc. Entomologique de France, Dec. 4, 1839, p. xlvii. tome viii.

§ Westwood's Introduction, vol. i. p. 298.

‖ Minute-Book Entom. Soc. Lond., Sept. 5, 1841.

¶ *Loc. cit.* p. xlvii. ** *Ibid.*

tain not only that the larvæ of *Sitaris* resemble those of *Meloë* in general form, but also that they are similar to them in their economy and parasitism.

Other families of *Coleoptera* allied to *Meloë* in the structure of the imago, resemble them also in the habits of the larvæ. This is the case, as formerly stated, with *Horia**, which in the larva state resides in the cell of the carpenter-bee, *Xylocopa Teredo*. The precise form of body in which *Horia* comes from the egg is unknown; and it is also unknown whether the egg is deposited in the nest of *Xylocopa*, or whether, as I strongly suspect, it is conveyed to it on the body of the female *Xylocopa* as an agile larva, like *Meloë*, *Lytta* and *Sitaris*. In that stage of growth in which it has been delineated and described by Lansdown Guilding, it is a short-legged hexapod, very like the larva of *Meloë* towards the close of its period of feeding, when it has been long located in the nest of its foster-parent, *Anthophora*. *Cissites maxillosa* and *C. testacea*, Javanese species allied to *Horia*, are said to reside as larvæ in deep burrows in the woodwork of houses†, probably formed by larvæ on which these are parasites. Of the larva of *Cerocoma* and its habits we are at present entirely ignorant.

Some other genera, less closely allied to *Meloë* than those we have noticed, differ from it somewhat in the form of the larva, and in the particular habits both of that and of the imago, but resemble it in its general economy of parasitism. *Rhipiphorus paradoxus*, the pest of the wasp's nest, is believed to deposit her eggs either in the larvæ‡ or in the cells§ of that insect. Another species, *Symbius Blattarum*, the female of which is apterous, is parasitic on *Blatta Americana*‖, and its form, as well as that of its larva, resembles that of *Sitaris*. A more rare species, *Rhipiphorus finnicus* of Paykull (*Pelecotoma Latreillei*, Fischer), which is peculiar to Finland, is stated by Count Mannerheim¶ to be parasitic on the genus *Chrysis*. It is often seen to issue from little holes in the doors of old wooden buildings, frequented by the *Chrysididæ* in their parasitism on other insects. This parasitism on parasites is of frequent occurrence amongst insects. Mr. Curtis

* Linn. Trans. vol. xiv. p. 316.
† Westermann in Silbermann, Rev. Entom. No. 3.
‡ Hope, Proceed. Ent. Soc.
§ Westwood, Introduction, vol. i. p. 294.
‖ Sundevall, in *Isis*, 1831.
¶ Rev. Zool. Feb. 1844, p. 64.

long ago* showed that one of the *Ichneumonidæ*, a new species, which he figured and described as *Anomalon vesparum*, Curt., is parasitic on the larva of the wasp in its cell. Since then, *Rhipiphorus paradoxus*, the usual parasite of the wasp's nest, has been stated by Mr. Hope to be itself attacked by an *Anomalon*, probably Mr. Curtis's species, and this to become the prey of one of the minute *Chalcididæ*†. Whether any of the true *Mordellæ* are parasitic is not yet ascertained. The aculeated form of body, so admirably fitted for piercing hard substances and introducing ova into the cells of other insects,—as the parasitic *Cælyoxys*‡, among bees, introduces its egg into the nest of *Saropoda*, —leads us to suspect the *Mordellæ* of these habits, although the contrary has been stated of some of them.

From this comparison of species, we find that those which most nearly approach to *Meloë* in the form of the imago, also most closely resemble it in the larva state, both in general structure and habit; while those which differ most in the form of the imago, do so likewise in the anatomy and economy of the larva.

This view of the relation which the habits of species bear to their peculiarities of organization, leads us to an examination of that anomalous order of insects, the *Strepsiptera*. These have many analogies with *Meloë*, both in their organization in the larva state and in their habits. They compose a very distinct group, members of which have been found in almost all parts of the world, and every one of which is a parasite. As I shall have occasion, in my attempts to point out the analogies of form and peculiarities of structure connected with special habits, to compare the form and economy of the early stages of the *Strepsiptera* and the *Meloë*, and to identify these with corresponding associations of form and habit in the truly parasitic *Anoplura*, it may be well first to give some general view of the facts known of the habits and structure of the *Strepsiptera*, more especially of their larva state, preparatory to a future examination of the special anatomy of *Meloë*.

* British Entomology, fol. 198, Jan. 1, 1828.

† Trans. Ent. Soc. Lond. vol. iii. part 1. (Proceed. p. iii. June 4, 1838.)

‡ Newport, Proceedings Entom. Soc. Lond. p. 109, July 1st, 1844; and President's Anniversary Address 1845, 8vo, p. 12.

The Strepsiptera *.

The whole of the *Strepsiptera* yet discovered, like *Meloë* and most of its affinities, are parasitic on the *Hymenoptera*. They are all of diminutive size. One

* *Bibliography of* Strepsiptera.

Rossi.—Fauna Etrusca, Mantissa, Append. p. 114. (*Xenos vesparum.*)

Kirby.—Monographia Apum Angliæ, vol. i. tab. 14. fig. 11. p. 257; vol. ii. p. 112, 1802. (*Stylops Melittæ.*)

Kirby.—Sowerby's British Miscellany, No. ix. pl. 45. fig. 94.

Jurine.—Mem. Acad. Turin, tom. xxiii., Observ. sur *Xenos vesparum*, 1805? (*X. Rossii*, Jur.)

Peck.—Kirby's Monog. of *Strepsiptera*, Linn. Trans. vol. xi. Sept. 1809–11. (*Xenos.*)

Klug.—Magazin der Gesellschaft Naturforschender Freunde zu Berlin, p. 266, 1810. (Supposed parasites of *Stylops.*) (*Strepsiptera.*)

Kirby.—Monograph of *Strepsiptera*, Linn. Trans. vol. xi. 1811–15. (*Xenos Peckii.*)

Latreille.—In Cuvier's Règne Animal. (*Rhipiptera.*)

Kirby.—Linn. Trans. vol. xi. p. 233, Feb. 16, 1813. (*Stylops tenuicornis.*)

Leach.—Zoological Miscellany, vol. iii. 1814? (*Stylops Kirbii.*)

Curtis.—British Entomology, folio 226, Aug. 1828. (*Stylops Dalii.*)

Stephens.—Nomenclature of British Insects, p. 37 (MS. name), 1829. (*Stylops Haworthii*? MS.)

Curtis.—British Entomology, folio 385, Dec. 1831. (*Elenchus Walkeri.*)

Dale.—Curtis's British Entomology, folio 433, Dec. 1832. (*Halictophagus Curtisii.*)

Jurine.—Isis, taf. xiii. 1832.

G. R. Gray.—Griffith's Cuvier's Anim. Kingd. vol. xv. (Ins. vol. ii. pl. 59. p. 633, 1832.) (*Stylops Childreni.*)

Stephens.—Trans. Ent. Soc. Lond. vol. i. pt. 3 (Proceed. p. lxv.), Aug. 1835. (*Elenchus* (*Stylops*) *tenuicornis.*)

Van Heyden.—Congress of Germ. Naturalists, Bonn, Sept. 1835, *vivâ voce.* (Supposed *acari* (larvæ) of *Xenos.*)

Van Heyden.—Trans. Ent. Soc. Lond. (Proceed. p. lxxiii.), Oct. 1835, vol. i. part 3. (*Id.*)

Pickering.—Trans. Ent. Soc. Lond. vol. i. part 3. p. 163, Jan. 1835–1836. (*Stylops Spencii.*)

Dufour.—Annales des Sci. Nat. tome vii. p. 19, Jan. 1837. (*Xenos sphecidarum.*)

Newport.—Art. Insecta, in Cyclop. Anat. and Physiol. pt. xvii. vol. ii. 1838.

Westwood.—Observations on *Strepsiptera*, Trans. Ent. Soc. Lond. vol. i. part 3. p. 169, 1835–1836.

Westwood.—Trans. Ent. Soc. Lond. vol. i. part 3, 1835–1836. (*Elenchus Templetonii.*)

Westwood.—Trans. Ent. Soc. Lond. vol. ii. p. 3, 1836–39. (Supposed parasites of *Stylops.*)

Siebold.—Ueber *Xenos sphecidarum* und dessen Schmarotzer, in Beiträge zur Naturgeschichte der Wirbellosen Thiere. Danzig (September), 1839. (*Xenos sphecidarum*, supposed parasites, *larva, pupa, imago.*)

Westwood.—Introduction, part xiv. p. 302, Nov. 1839. (Supposed parasites of *Stylops.*)

Guerin & Percheron.—Insectes. (*Rhipiptera.*)

Thwaites.—Notes on *Stylops*, Trans. Ent. Soc. Lond. vol. iii. pt. 1. p. 67. (Proceedings, June 1838–41.)

Thwaites.—In Westwood's Introduction, p. 300. part xiv., Nov. 1839.

of the giants of the species, *Stylops Spencii,* is scarcely one-fourth of an inch in length ; while the pigmy genus, *Elenchus,* is scarcely more than one-fourth even of this dimension. But size in the material world, like space or time in the ethereal or immaterial, is merely a relative condition, and is of little moment to the philosophical inquirer, while engaged in investigating the laws by which the Deity has ordained the development of structure,—the evocation of life,—or the evolution of function and instinct. The organization and habits of the tiny *Stylops* are as much proper subjects of investigation, of wonder and admiration, to the right-thinking mind, as are those of the Leviathan of the deep, or of the Elephant of the forest; whilst their very diminutiveness and isolation, like all microscopic analyses of organism, or singleness of action, tend greatly to facilitate our investigation of principles, and lead us more easily to understand those on which structure is formed, and function and instinct are unfolded.

Like the Meloës, the *Strepsiptera* are parasites on the *Aculeata*, the sand-wasps, wasps and bees, which nidificate in banks of dry earth or sand exposed to the sun; localities as essential to the development of the parasites themselves as to that of the species which they infest.

The first discovered of these singular insects, the *Xenos vesparum* of Rossi, was regarded by him as constituting a new genus of *Hymenoptera* allied to *Ichneumon.* Another species was discovered soon afterwards by our countryman the Rev. William Kirby, who at once perceived, without being aware of Rossi's discovery, that his insect, a new species, belonged not only to a new genus, which he designated, from the form of its eyes and the bee it was found on, *Stylops Melittæ*, but that it constituted the type even of a new Order of Insects. When a second species of *Xenos*, *X. Peckii*, was discovered some time afterwards by Professor Peck of Boston, and communicated to Mr. Kirby, this gentleman then formed the species into an Order, which he

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Lewis.—In ditto, p. 305. part xiv., Nov. 1839, new species? Van Diemen's Land.

Templeton.—Trans. Ent. Soc. Lond. vol. iii. part 1. p. 51, 1838–1841. (*Xenos Westwoodii.*)

Siebold.—Wiegmann's Archiv, 1843. (*Metamorphosis of Strepsiptera, larva, nymph, imago.*)

Guerin.—Revue Zoologique (abstract of the preceding, with notes), March 1844, p. 111–118.

Newport.—Anniversary Address Ent. Soc. Lond., Feb. 1845, pp. 19, 20. (*Larva, nymph, imago.*)

F. Smith.—In 'The Zoologist,' No. xxiii., Sept. 1845, p. 1092–93. (*Larvæ of Stylops.*)

characterized in the Transactions of this Society as the "STREPSIPTERA," from the twisted form of the rudimentary elytra with which the male individuals are furnished. Rossi's insect had in the meantime been examined by Professor Jurine, who distinguished it from another species, also found in the wasps. Mr. Kirby and Dr. Leach afterwards each described additional species, *Stylops tenuicornis* and *Stylops Kirbii*; and Mr. Curtis and Mr. Dale each characterized a new genus, *Elenchus* and *Halictophagus*. These were followed by new species by Mr. G. R. Gray, *Stylops Childreni*; by Mr. Pickering, *Stylops Spencii*; by Messrs. Templeton and Westwood, *Elenchus Templetonii*; and by Leon Dufour, *Xenos sphecidarum*,—the whole of which were found to be parasitical in their habits. Yet none of these naturalists were able to ascertain anything perfectly conclusive respecting the sex of the species they had captured. Professor Peck had however suspected that the four specimens of *Xenos* obtained by himself were males; although Rossi imagined that the winged specimens which he obtained were of both sexes. From what is now known we are satisfied that this was an error. It has been well ascertained by Dr. Siebold that the male sex only is winged. This fact established, raised at once a difficulty in understanding in what way these insects are propagated, and by what means the females are brought into communication with the species of bee or wasp on which they are parasites. M. Klug, in 1810*, appears to have been the first to observe a fact that has since led the way to an explanation of this problem in their natural history. He remarked that the *Strepsiptera* are sometimes covered with little hexapods, which he regarded as parasites.

In December 1834, Mr. Pickering, in this country, obtained from its nidus† in a sand-bank a living specimen of *Andrena tibialis*, which had recently assumed the imago state, and had never left its cell. In this specimen he "observed some protuberances between the abdominal segments, and thinking the bee might be stylopized, endeavoured to remove one of these swellings," out of which he obtained a living (male) *Stylops* (*Stylops Spencii*), which, like the insect it infested, had recently become perfect. This fact, as

* Nachricht von einen neuen Schmarotzer insekt auf einer Andrene. Magazin der Gesellschaft naturforschender Freunde zu Berlin, 1810, p. 266.

† Trans. Entom. Soc. Lond. (Proceedings, Jan. 5, 1835), vol. i. p. 164.

Mr. Pickering argued, at that early period of our knowledge of the habits of *Strepsiptera*, incontestably proved that the parasite is admitted into the cell of the young bee before the cell is closed by its parent,—a view which has since been completely verified by the observations of Dr. Siebold. Two other specimens of *Stylops* in Mr. Pickering's bee appear to have been females; so that both male and female *Stylops* have been found in the same insect. Some months after this, M. Van Heyden, of Frankfort, stated at the Congress of German Naturalists, held at Bonn in September 1835, that he had met with three species of *Xenos* (previously shown by him to the Rev. F. W. Hope*), *X. Rossii*, in *Polistes gallica*, and two others, one, much smaller than *X. Rossii*, in a species of *Odynerus*; and that he had found the body of the former sometimes filled with minute living hexapods, which he also regarded as parasites, and which resembled *Acari*, but which had the abdomen articulated. Further, Mr. Pickering in the following April (1836) obtained similar hexapods from *Stylops*†. Mr. Westwood, who had been directed by Van Heyden himself to the fact of the occurrence of these little objects in *Xenos*, and who had received from Mr. Pickering some specimens of these acariform bodies obtained from *Stylops*, and preserved in spirit, afterwards, in the month of June 1836, found similar specimens on a stylopized bee, *Andrena Gwynana*, Kirb., in his own possession. These he also described in the Transactions of the Entomological Society as the *parasites* of *Stylops*‡; but questioned, in a note to his paper, whether these supposed parasites might not be the young of *Stylops*, and the supposed pupæ, seen by Rossi, Kirby, Peck, and all subsequent observers, partially projecting from beneath the margin of the abdominal segments of the stylopized insects, be the females?, as, up to that time, and even to a still more recent period, the female *Stylops* remained unknown. Mr. Westwood added, however, "*that he should be very fearful of asserting this as the fact.*" Yet such has since been shown by Dr. Siebold to be the truth. This distinguished naturalist, in 1839§, not only found similar hexapods on

* Trans. Entom. Soc. Lond. vol. i. part 2. (Proceedings, xxxix.)

† See Mr. Westwood's paper on the *Parasites of Stylops*, Trans. Ent. Soc. vol. ii. part 3. p. 184, 1836–39.

‡ *Loc. cit.*

§ Ueber *Xenos sphecidarum* und dessen Schmarotzer, in Beiträge zur Naturgeschichte der Wirbellosen Thiere, Dantzig, 4to, 1839.

Xenos sphecidarum, and which, like previous observers, he then thought were parasites, but he also discovered and described the ova in which they were produced within the body of the *Xenos*. More recently * he has shown that these are the ova and the young of *Xenos*; and that the female *Strepsiptera* are blind, apodal, larviform insects, that never leave the bodies of the *Hymenoptera* in which they have lived as parasites, but remain with only the cephalo-thoracic portion of their bodies exposed, and there produce their young and die. The males escape, and fly abroad as winged insects, and impregnate the females while these are still within the *Hymenoptera* in which they have been nourished. The larvæ, consequently, as in *Hippobosca*, *Aphis*, and some other of the inferior parasitic tribes, are hatched within the bodies of their parents, and pass out, to the surface of that of the wasp or bee, through the vulva, which is situated in her cephalo-thorax on the ventral surface. The larvæ thus produced (TAB. XIV. fig. 21), like those of *Meloë*, are at first distinctly hexapod, and capable of locomotion; they cling fast to the hairs on the body of the wasp or bee (TAB. XIV. fig. 22) in which they have been hatched, and are transported by the insect to its nest, where they remain, as I have already shown is the case with *Meloë*. The larvæ of *Strepsiptera* penetrate the body of the young larva of the hymenopterous insect in its cell, and locating themselves in it, shed their skins, lose their legs, become completely apodal, and there feed on its substance, through the whole period of their nutrition, as internal parasites. These facts have been fully exemplified by Dr. Siebold†. The attention of naturalists was drawn to them quickly after their publication, in France, by MM. Milne Edwards‡ and Guerin Meneville§, and in this country by myself‖, my friend Mr. Spence having kindly apprised me of them. Since then, some of them have been confirmed by Mr. Smith's¶ and my own observations. I have detailed Dr. Siebold's discoveries here, in their natural sequence, in order, first, more fully to confirm them, and to add something to the description and history of these singular insects; and next, to be enabled more readily to compare the anatomy and habits of the larvæ with those of *Meloë*.

* Wiegmann's Archiv, 1843.

† *Ibid.* p. 137 *et seq.*

‡ Ann. des Sci. Nat. 1844.

§ Rev. Zool., March 1844, p. 111–118.

‖ Anniversary Address Ent. Soc. Lond., Feb. 1845, pp. 19, 20.

¶ Zoologist, No. xxiii., Sept. 1845, p. 1092.

On the 19th of May 1845, I received a female specimen of *Andrena Trimmerana* from Mr. W. Wing, which he had captured at Hampstead on the preceding day, with a *Stylops* projecting from beneath the fourth abdominal segment. This specimen I preserved in spirit for dissection. On examining it I found the body of the *Stylops*, which was a female, greatly enlarged, and occupying at least one-fifth of that of the interior of the bee. It extended backwards from the fourth segment of the abdomen to the base, on the dorsal surface, forcing downwards and compressing the whole of the viscera, which were more or less atrophied. The alimentary canal of the bee was almost empty, and thrust out of its usual position; the respiratory organs were small and imperfectly developed, and retained more the tracheal condition of the bee-larva than that of the adult insect, the vesicles being few and imperfect. The secretory vessels and poison-bag of the sting also were of diminutive size, and even the ganglia of the abdominal portion of the nervous cord seemed to have been atrophied, and were smaller than usual. But the most marked effect of the parasite on its victim had been produced on her organs of reproduction. The oviducts were of ordinary length and size, but the ovaries were entirely undeveloped, and were scarcely larger than they are at the period when the bee-larva passes to the state of nymph. They contained only the germs of a few very imperfect ova.

These effects on the development of the internal organization of the bee, and of all insects which undergo a complete metamorphosis, are the usual results of the exhaustion of their vital energies by the presence of internal parasites. I have constantly observed like effects produced on the organization of the *Sphinx Ligustri* by its internal parasite, the larva of *Ichneumon Atropos*; and these effects are equally injurious to the male as to the female victim. They seem to be produced mainly by the abstraction by the parasite, —which subsists on the adipose tissue, and not on the viscera of its victim,— of a portion of that supply of nourishment which is accumulated in its body during the feeding or larva state, to furnish materials for the growth and development of the whole organism.

In a male pupa of *Sphinx Ligustri*, which I preserve, the facts now stated are well shown. The full-grown larva of the *Ichneumon*, imbedded in the fatty tissue on the dorsal surface of the body, has compressed the alimentary canal,

and retarded its changes; the tissue itself is thin and partially destroyed; the air-sacs at the sides of the abdomen, which are exceedingly large in the male imago *Sphinx*, are but little advanced in their development; the brain is smaller than in pupæ of the same age; and the male organs of reproduction, the testes,—which always become united into one mass immediately the larva *Sphinx* has changed to a pupa,—remain widely separated as in the larva, their form only being somewhat altered.

These facts show, that insects infested with internal parasites are often sterile. The *Sphinx* dies of its injuries before assuming the imago state; while the bee lives on to perpetuate the enemy of her tribe, and be herself the means of transporting it to the nidi of her own or of others' young, as she conveys thither also the parasite, *Meloë*.

Of the Female Stylops.

The structure of the female *Stylops* (Tab. XIV. fig. 20) is as full of interest as are the effects of her presence on the organization of the bee. I was anxious to examine most carefully, in the specimen I had obtained, that portion which is of a corneous texture, and protrudes between the abdominal segments of the bee (A), and which, Dr. Siebold has shown, is not merely the head, as naturalists have supposed, but the entire cephalo-thorax. This most certainly is the fact. On the concave, or *dorsal surface* of this part, I have been able to recognise the four segments which constitute the head and thorax of the young larva firmly united together into one region. In the first, the true head, there are no eyes or antennæ; and in the others, the prothorax, meso-thorax and metathorax, there are not even the slightest indications of legs or other appendages. When viewed by strong transmitted light, I found the latter two segments, as in the enlarged abdomen (B), crowded with ova in various stages of development, converging towards the middle line at the anterior of the mesothorax, which corresponds to the oviduct on the ventral surface. The *ventral surface* is convex, and divisible like the dorsal into its original segments. At the sides of the anterior one are two quadrangular, flattened, corneous bodies (*a*), which, with Siebold, I regard as rudimentary mandibles. Between these is a cruciform opening, the buccal orifice, bounded posteriorly by two thin plates (*b*), probably the labial, divided by a longitu-

dinal suture. Behind these is a free crescentic margin (*c*), the boundary of the united pro- and meso-thorax. This margin conceals the vaginal outlet of the oviduct, which is in the fold between the head and thorax, as stated by Siebold. Its situation is very analogous to that of the outlet of the female reproductive organs in the *Iulidæ* and other vermiform *Myriapoda*, in which the vulva of the female is in the mesothorax.

I regret that I was unable, through want of specimens, to make so precise an examination as I could have wished of the abdominal viscera of this insect. The abdomen (B) was soft, and divided into eight segments, and so large in comparison with the cephalo-thorax as to resemble greatly that of the pregnant female *Termites*. I had ruptured it while opening the body of the bee, so that I was unable to determine its precise form; but noticed however that it was well-supplied with tracheal vessels, the chief of which at the sides near the base, and apparently connected with a large spiracle, as shown by Siebold, were of large dimensions, thus indicating a great extent of respiration. Like the body of the *Termites*, it seemed to constitute one immense ovary, crowded with thousands of ova of all sizes, in various stages of development, from the immature egg to the egg with the embryo almost ready to burst its envelopes.

The Egg and Embryo of Stylops.

The smallest ova which presented signs of having been fecundated and the development of the embryo commenced (fig. 23), were of a spherical form, and filled with a dark, yellow-coloured yelk, composed of masses of large nucleated cells (*a*). The yelk was surrounded by a transparent, colourless blastoderma (*b*), and on one side (*c*) was impressed with a transverse sulcus. When measured on a micrometer-plate these ova did not exceed each at most one five-hundredth of an inch in diameter. Multitudes of others, which had not acquired their full size (fig. 24), measured only one thousand five-hundredth, or one two-thousandth of an inch. Those in which the changes had advanced sufficiently far as to indicate, by the doubling of the blastodermic layer on itself (fig. 25, *d*), a shadowing out of the form of the future embryo, measured about one three-hundred-and-fiftieth of an inch. Others, a little further advanced, in which the outline of the embryo was more distinctly indicated (fig. 26), organization having been carried to that stage in which the greater

portion of the yelk is included in the blastoderma, and is beginning to disappear as a separate body, measured one two-hundred-and-fiftieth of an inch. In the next stage (fig. 27), which shows that the last portion of the yelk is inclosed on the dorsal surface of the thorax of the embryo *Stylops* (B), as observed by Rathke in the *Crustacea*, the form of the ovum is altered. It is slightly flattened at its sides, is oval, and measures one two-hundredth of an inch. The body of the embryo is now seen partially coiled on itself, with its abdominal portion bent under the thoracic, and with its dorsal surface next the interior of the shell; it consists entirely of an aggregation of yelk-cells, partially inclosed in a blastodermic membrane, which completely invests the folded portion, the ventral surface of the future larva, but is open on its dorsal, being gradually closed from behind forwards to the thorax at a subsequent period. On the anterior portion of the membrane, which is to become the tegument of the thorax, three slight transverse folds (*f*), which originated in the previous stage of organization, now form on each side three broad tubercles that project slightly from the surface; these are the germs of the future legs. A distinct membrane inclosing the entire embryo in the shell is now visible (*g*). In the next stage (fig. 28), the ovum has acquired a diameter of about one-hundred and seventieth of an inch. The membrane that invests the embryo is more distinct, the pedal tubercles are elongated and pointed at their apex, and the remains of the yelk are rapidly becoming included in the thorax, which is much enlarged, but is not yet closed on its dorsal surface. At a still later period (fig. 29) the form is recognizable as that of the larva of *Stylops*. The ovum is more elongated anteriorly, and measures one hundred and fiftieth of an inch. The dorsal surface of the thorax is closed. The tubercular legs now have the rudiments of tarsal and tibial joints; the head of the embryo begins to project slightly from the thorax, the investing membranes are more distinctly marked, and the body exhibits a more organized and less celliform appearance. At a further advanced stage (fig. 30) the ovum is still more elongated, and is more flattened at its sides, the investing coverings of the embryo being put on the stretch by the growth and extension of the body. The ovum now is about one hundred and twentieth of an inch in diameter. Still later (fig. 31) it has reached to one hundredth of an inch. The legs of the embryo have acquired almost their proper length, the amnion which in-

closes the embryo is tensely stretched, the segments of the thorax of the future larva, as well as those of the abdomen, are distinctly marked, and traces of an alimentary canal are easily distinguished, although the whole interior of the body is still composed of cells. In the last stage of the embryo (fig. 32), immediately before rupturing its envelopes, the ovum measures about one-eightieth of an inch in its long diameter. The embryo is now completely formed. The whole of its abdominal segments, as well as its thoracic, have their armature of marginal spines. The minute head of the embryo, flattened, acute and wedge-shaped, projects forwards from the prothorax, and pressing against one portion of the envelopes whilst the caudal extremity is forced, by the growth of the body itself, in an opposite direction, the ovum is made to assume an irregular ellipsoid form, and by a continuation of the forces of growth the membranes and shell are at length burst, and the young *Stylops* comes forth in the oviduct of its parent as an active hexapod. The whole of these changes take place in the ovum within the body of the female *Stylops*, herself contained within that of the bee.

I regret that I was unable to obtain other specimens of *Stylops* for dissection at the period when the larvæ have burst their envelopes. Enough however is shown in these observations to prove, with Dr. Siebold, that the female *Stylops* is viviparous; and also, that the eggs do not all become matured at precisely the same period, but that there is a range of some days between the hatching of the earliest and of those which appear last. That this is the fact, was proved to my satisfaction in observations made on another stylopized specimen of *Andrena*.

On the 27th of May, only a few days after receiving the specimen which contained these embryos, Mr. Smith favoured me with the loan of a stylopized *Andrena Trimmerana*, which he had also captured at Hampstead about the 8th or 10th of that month, and which had been in his possession alive during the intervening sixteen or eighteen days. The bee died on the 25th of May, and on the same day one or two specimens of *Stylops* larvæ made their appearance. On the following day many more came forth; and soon after the bee was placed in my hands they issued from the vaginal fissure (fig. 20, *c*) of the *Stylops* in such abundance, that they completely covered the whole of the posterior part of the abdomen of the bee, both on the upper and under surfaces, like dust, which

to the naked eye they closely resembled. They were intermingled with, and adhered very tenaciously to the hairs, and walked about on the body of the *Andrena* like the larvæ of *Meloë* on the *Anthophora*, but far more slowly. Mr. Smith* has published a few remarks on the larvæ obtained from this insect. Besides this specimen, Mr. Smith captured one other, which contained three pupæ of *Stylops*, from one of which a male *Stylops* came forth on the following day. This male he has figured as the *Stylops Melittæ* of Mr. Kirby; but there is reason to believe that, although it approaches closely to that species, it may be distinct from it, and perhaps is yet undescribed. Should this prove to be the case, I propose to describe it as *Stylops aterrimus*, from its uniform and intense black colour. It resembles Mr. Kirby's insect in size, general colour, shortness of the abdomen, and pedunculation of the eyes, and in the front of the head being obsoletely trilobed; but it differs in having the occipital border of the head deeply emarginated, whilst in the figure of *Stylops Melittæ*† given by Mr. Kirby this is entire. The antennæ, head, thorax, wings, legs and abdomen are all of a deep black. Further, it may be worthy of remark, that the species of bee on which it is a parasite is *Andrena Trimmerana*, Mr. Kirby's being *Andrena nigro-ænea*.

About the time of capturing the specimens above-mentioned, Mr. Smith informs me that he took also two or three stylopized male bees, in one of which there were two specimens of the parasite. Stylopized male *Hymenoptera* however, he remarks, are exceedingly rare. In this he coincides with Jurine and Siebold.

The Larva of Stylops.

The larvæ of *Stylops* obtained from the specimen of *Andrena Trimmerana* I have no doubt were of the same species as the male *Stylops aterrimus* from the same insect. The length of time which elapsed between the capture of the bee on the 8th or 10th of May, and the 25th of the same month, that at which the parasite began to produce the larvæ, is an interesting matter for consideration, with reference to the period which usually elapses between the impregnation of the female and the hatching of her young. Supposing the female *Stylops*, at the moment when the bee was captured, to have been only

* *Loc. cit.*

† Kirby, Monog. vol. i. tab. 14. fig. 11. 1, *a*. (*loc. cit.* vol. i. p. 257. No. 11.)

very recently impregnated, or, at latest, on the day afterwards, when the male *Stylops* came forth, the eggs within her body were at least from sixteen to eighteen days before they gave birth to the larvæ. Having the specimen of *Andrena* at the second day after the young *Stylops* began to make their appearance, I had full opportunity of observing them issue from their parent. Their number was truly astonishing. Mr. Smith calculated that from two to three hundred came from this single specimen, but this is very far short of the real number, which, for so small an object as the female *Stylops*, was incredible. I am almost afraid to state, lest I should subject myself to doubt, that my own observations lead me to believe there were more than twice as many thousands; since, in a small collection of some of these very specimens, which I preserve between plates of talc, there are nearly two hundred and fifty, yet these do not constitute one-tenth of those produced, and there are still more than three times as many of these larvæ attached to the preserved bee now exhibited* from Mr. Smith's cabinet.

So extremely small are these little insects at their birth, as already shown in the account given of the ova, that, on measuring them on a micrometer-plate beneath a high power, I found that their average length did not exceed twenty-two thousandths, or about one forty-sixth of an inch,—one-twelfth of that of the male insect in the imago state.

When we contemplate for an instant this diminutive *Stylops* clinging to a hair of the bee in which it has been bred (fig. 22), and then glance to the *Mylodon* of old,—the gigantic Sloth of a former world,—and remember that the same primary laws of organization have regulated the production of both, we are as much lost in wonder and astonishment at the comprehensiveness of those laws, as when contemplating those which regulate the motions of the universe. The larva *Stylops* has its system of parts for motion, for the assimilation of food, and for the aëration of its fluids, like the most perfect animals. Its body is formed of fourteen segments, including the head and anal segments. It is hexapod, and is furnished with long caudal setæ.

The *head*, or first segment, is short, rounded anteriorly, and a little depressed in the middle, and on its upper surface there is a lunated row of

* The stylopized *Andrena*, together with specimens of the larvæ, were exhibited to the Society at the reading of this paper.

eight bright points, which have the appearance of ocelli. These are arranged transversely on the front of the head, so that when the larva depresses this part, which it usually does towards the ventral surface, these bright points are directed forwards. I have been unable to determine whether these are, like the ocular tubercles of the *Arachnida*, real ocelli, or whether they are merely dermal tubercles, analogous to those which are developed into spines on the thoracic and abdominal segments; or whether, as there seems reason to suspect, the ocular and dermal tubercles are not identical in their mode of origin from distinct cells in the tegument, which differ only relatively, in the extent to which the development of the primary constituents of their nuclei and nucleoli are carried. I have not been able to detect the existence of the ocelli pointed out by Dr. Siebold in the larvæ of *Xenos* and *Stylops*: probably I have overlooked them. Neither have I been able to satisfy myself that the young *Stylops* possesses even the slightest rudiments of antennæ. The parts of the mouth I have seen exactly as described by Siebold; but they are usually retracted and difficult to observe. The head also is partially withdrawn beneath the prothorax, somewhat as in the carnivorous larvæ of the *Lampyridæ*, and perhaps, as in them, the head and mandibles are extruded only at the moment of attack on the prey. This retraction of the head and mouth beneath a shield-like prothorax is common to larvæ which penetrate into other bodies, as *Silpha*, *Dermestes*, *Lampyris*, &c. amongst the *Carnivora*, and *Cerambyx* and other *Xylophaga*.

The second segment, the *prothorax*, is the largest of the whole body, and much resembles the corresponding part in other larvæ. The third and fourth, the *meso-* and *meta-thoracic* segments, are shorter than the second, but are broader than the following abdominal ones. These three segments give attachment to the legs. The remaining ten segments constitute the abdominal region. In the living insect they are each longer than the meso- and meta-thoracic segments, excepting only the anal or terminal one. Each segment is armed on its posterior margin with a row of spines. These are short on the thoracic segments, each alternate one being only half the length of the adjoining. On the abdominal segments their length is gradually increased, until those on the posterior measure one-third or nearly one-half of that of the segment. Instead of each alternate spine only being elongated, nearly

the whole on each segment are of equal length, so that the appearance of the larva under the microscope strongly reminds us of the genus *Polyxenus* among the *Myriapoda*, or of the larva of *Attagenus* or *Dermestes* amongst the *Coleoptera*. The ninth segment of the abdomen, the thirteenth of the whole body, is armed with a pair of elongated caudal styles or setæ; and the inferior surface of the fourteenth or anal segment is soft, prehensile, and employed by the larva in locomotion, like the anal prolegs in other larvæ. The caudal styles are distinctly articulated to their segment by a large and a small joint, but I have not been able to detect any articulation in the remaining portion of these organs with the instrument I have employed, a triplet magnifying about 450 diameters.

The *legs* are formed of a *coxal* joint, a *femur*, a *tibia*, and a four-jointed *tarsus*. The *coxa* is a large and powerful joint; the posterior one is much larger than the others, and the whole are armed, each with four curved stiff spines. The *femur* is also a strong joint, and has two small spines at its distal, or tibial articulation. The *tibia* is elongated, slender, and somewhat clavated at its articulation with the tarsus, where it has a short spine on its internal margin. The *tarsus* is long and composed of four joints. The basilar joint is very short, but the distal one is large and spatulate. It is in fact a double joint, so that the true tarsal joint is the shortest, and the first metatarsal is the longest. The tarsi of the posterior pair of legs are much smaller and shorter than those of the first and second pairs. The third and fourth terminal joints are not spatulate, but are very narrow, weak and slender. This appears to be a character common both to *Stylops* and *Xenos*.

Locomotion of the Larva of Stylops.

When the larva attempts to walk on a smooth surface, as on glass, it moves very tardily, and its long tarsi are bent irregularly; but when attached to the hairs or body of a bee, its power of locomotion is much greater. When climbing up a hair it moves almost precisely like the larva of *Meloë*, but very much more slowly. It first shortens its segments and affixes itself firmly to the hair with its anal prolegs, and then, elongating its body, steps onwards, making use of its thoracic legs alternately in the act of progression. When left for a few hours on some hairs from a bee, on the glass object-plate of a microscope,

the larva does not readily quit them. I left four or five specimens during the night, on hairs, beneath the microscope: three of the larvæ were attached to the hairs. In the morning two of them had escaped, and one only was still clinging to a hair; so that we may fairly conclude that they sometimes wander in search of the object of their parasitism.

Internal Anatomy of Stylops.

I have succeeded in tracing the alimentary canal of the larva throughout its whole course, and I believe am enabled somewhat to extend the observations of Dr. Siebold on this part of its anatomy. Dr. Siebold describes the larvæ of the species he examined, *Stylops Melittæ* and *Xenos Rossii* and *sphecidarum*, as having a simple cæcal intestine, but no anal outlet. My own observations lead me to a different conclusion. The *alimentary canal* commences in a narrow œsophagus, which is gradually enlarged as it passes backwards through the thoracic segments, until it has reached the first abdominal one, where it is dilated into a kind of crop. An abrupt constriction, the cardiac valve, separates this from the continuation of the canal, the true stomach, or *chylific ventricle*. This part is considerably enlarged, and commences within the posterior margin of the first abdominal segment, the fifth of the whole body, as in other insects. The canal then pursues nearly a direct course as far as the ninth segment, the fourth of the abdomen, in which it is folded on itself and again turns forward, that portion which passes forward being on the under surface. This gives to the anterior, the uppermost portion of the chylific ventricle, an appearance of cæcal termination. I suspect it was this appearance which led that distinguished observer Dr. Siebold to describe the canal as simple and merely cæcal. When the canal has thus passed forwards for a short distance, it is again folded backwards in the next segment, and is then indistinctly traced onwards until seen in the thirteenth segment as the *rectum*. I have no doubt that a true anal outlet exists to the canal at this period of the larva state, although it is not improbable it may become closed at a subsequent one, when the parasite is included in the abdomen of the bee larva. I have indeed noticed what seems to be a demonstration that the canal in the young larva is not closed. While observing a larva that was moving along on a plate of glass, a little fæcal mass seemed to be voided by

it. The mass was brought into view precisely in the middle line, between the caudal setæ, at the instant when the larva was in the act of carrying its posterior segments forward, so that the fact could hardly be mistaken. This appears to be sufficient evidence of the existence of an anal outlet to the digestive canal. That this may become closed at a subsequent period, when the *Stylops* larva has penetrated into the interior of the body of its victim, is highly probable, although it is most certainly permeable in the male imago, which Mr. Pickering saw void a whitish fluid immediately after it came forth, analogous probably to that passed at a similar period after evolution from the pupa state by the *Lepidoptera* and other insects. The *Stylops* larva, near the end of its period of nutrition, in its apodal state, has been found by Peek, Jurine and Dufour completely inclosed in the body of the hymenopterous insect, feeding, according to Dufour's observations, on the adipose tissue only, and not on the vital structures.

Respiratory Organs of Stylops.

The complete occlusion of *Stylops* within the body of another insect renders the consideration of the manner in which the function of respiration is performed, or the aëration of the fluids in the parasite is effected,—a condition essential to life,—a matter of interest equal with that of the closure of the outlet to the digestive canal. It can hardly be imagined that an insect, the male sex of which in its perfect state is one of the most active and fully developed of the winged tribes, does not possess, in its larva state, organs in some form or other fitted for an extensive aëration of its fluids. The existence of a large spiracle in the thorax of the female *Stylops* communicating with large tracheæ extensively ramifying through its tissues, shows that while it is passing the greater portion of its existence surrounded by delicate organs in the body of another animal, and as it were bathed in its fluids, it yet maintains for itself a free and perfectly independent respiratory function of its own.

In all the larvæ I have examined there have appeared to be eight pairs of bag-shaped dark-looking bodies within the abdomen, one pair at the sides of each segment, from the *fifth*, or second abdominal segment to the eleventh inclusive, situated in the exact place of the respiratory organs of other insects. From their darkened appearance, and from their resemblance to branchial sacs, these may perhaps be regarded, at this period of the larva's existence, as

imperfect respiratory organs, of the nature of branchiæ. A branchial form of respiratory organs we know exists in the aquatic larvæ of insects which, in their perfect state, respire atmospheric air, and it is not improbable that a like condition of the respiratory organs exists in the early states of this parasite. The larva of *Ichneumon atropos*, however, in which I have found that there certainly is no outlet to the alimentary canal, and which, as before stated, subsists on the adipose tissue and fluids of the caterpillar, has true, but extremely minute spiracles and air-vessels, and although completely inclosed in the body of the caterpillar, seems to respire the air directly, perhaps from the injured air-vessels of its victim.

Development of the Larva of Stylops.

When the young *Stylops* has penetrated the body of the bee-larva, shut up in its cell in the earth in the spring, it grows as rapidly as the larva itself is nourished. It certainly changes its skin once, and perhaps oftener, like other insects. Its need for organs of locomotion, and for the perception of surrounding objects, is then reduced to a minimum. Accordingly, as I shall presently show takes place also in *Meloë*, inclosed in the cell of *Anthophora*, the legs with which the young *Stylops* was provided when it issued from the body of its parent become atrophied, and their further development is so completely arrested in every part, owing, perhaps, to the excess of growth which is taking place in its other structures, that they entirely disappear, being first reduced to their merest possible rudiments, pedal papillæ, which are more and more reduced in size as the growth of the body proceeds. On the other hand the body of the *Stylops* becomes so enlarged by the nourishment ingorged from the substance of the body of the bee-larva, that its entire form and proportions are completely changed.

During the period of its growth, the parasite, as found by Dr. Peck * in *Xenos*, lies with its head in the direction of that of the insect preyed upon,—that probably in which it entered the body. But when it has arrived at its full growth, and is about to change to a nymph, its position in the body is reversed, and adapted to its future exit backwards between the rings of the abdomen of the hymenopterous insect. Its change to a nymph takes place in

* Trans. Linn. Soc. vol. xi.

the summer or autumn, and probably always subsequent to the change of the bee- or wasp-larva. This I have found most certainly the case in *Ichneumon Atropos*, in *Sphinx Ligustri*, which remains in its original position, but never changes to a nymph until long after the caterpillar in which it lives has become a chrysalis. The changes of the *Stylops* follow those of the insect on which it is a parasite in quick succession. The bee has often completed its changes in the autumn, but, as naturalists are aware, does not then leave its cell. It remains in it during the winter in a state of hybernation, and comes forth in the spring. The *Stylops*, like the bee, also appears to complete its changes in the autumn, as is proved by the fact related by Mr. Pickering*, that a living male *Stylops* issued forth from the body of an *Andrena tibialis*, which he dug out of its cell alive at the end of December. That the apodal females also undergo their slight change, and are prepared to emerge between the segment of the bee at about the same period as the males, has been proved by Dr. Siebold.

Comparison of the Sexes of Stylops.

A comparison of the sexes of *Strepsiptera* exhibits perhaps one of the most striking contrasts we are acquainted with in nature. Every structure of the body in the male which has relation with the external world exists in a condition the very opposite of that of the female. In the one sex the organs of sense and locomotion are developed to their utmost extent; in the other their development is arrested at its very commencement. Yet both sexes exist under precisely similar conditions of structure and relation at the moment of their liberation from the incubatory organ of their parent, and during their larva period of nutrition. When this period is completed, the formative energies or forces of the primary constituents of the body in the one are concentred in the production of ova,—of thousands of similar combinations of matter, each constituted to result in the formation of an organized body, identical with that in which it has itself been produced. In the other sex the powers of life are not exhausted simply in the production of new combinations, but mainly are employed in the unfolding of those which belong to the body itself, and which are to bring it into immediate communication with the external world as an independent being. The sole design of the existence of the

* Trans. Ent. Soc. vol. i. part 3, p. 164 *et seq.*

male appears to be centred in the consummation of a single object,—identical with that of the female, and of absolute need to enforce the evolution of the materials of the ova within her into new organisms. To this the functions of all the newly-expanded structures in the male are mediately subservient. For this alone the little *Stylops* enjoys its brief existence of a few hours on the wing,—a life of the utmost activity and excitement,—and perishes in less than a day. For this great intent of active being it bursts forth with its expansive organs of flight, and with its antennæ and its organs of vision more extensively developed, perhaps, than in any other insect. Vision seems to be of paramount importance to it. Each mass of eyes is placed on a footstalk, and projects widely from the head, of which the two form the greater proportion. Each constitutes from two-thirds to three-fourths of a sphere, so that the sense of vision, as in the male of the hive-bee, and in that of the glow-worm, can be employed at the same instant in every direction. May not the omniscient object of this excessive development of the eyes in *Stylops*, be the detection on the wing of those *Hymenoptera* which carry about with them through the air the apodal female that awaits impregnation? The assignment of such reason for this extraordinary development of the eyes in the male, which organs are entirely absent in the female, may not, perhaps, be inconsistent with the truth. The imago *Stylops* lives not for itself, but for the perpetuation of its kind. It takes no food, as possibly the passage to its alimentary canal is then closed. Yet all its organs of consensual function, its antennæ, its palpi, its eyes, are developed to their utmost extent, relatively to its other structures, and its transient life is one of incessant action. Dr. Peck described its ceaseless agitation as the "tremblings of eager desire*," and all the facts of its natural history support this conclusion. Peck says that his insect, *Xenos Peckii*, which he confined under a watch-glass, "coursed round its prison with surprising trepidation as long as it lived, which was but a few hours." Mr. Dale says, that a *Stylops* caught by himself on the wing (*Stylops Dalii*, Curtis), when placed under a glass in the sun, "became quite furious in its confinement, and never ceased running about for two hours. The elytra or processes were kept in quick vibration, as well as the wings; it buzzed against the sides of the glass with its head touching it, and tumbled about

* Trans. Linn. Soc. vol. xi.

on its back*." The same gentleman remarks of another species, *Halictophagus Curtisii,* Dale, that it died on the evening of the day on which he captured it†; and Mr. Halliday states of another, *Elenchus Walkeri,* Curtis, that the only specimen he could "succeed in bringing home alive he put under a watch-glass, but having left it for an hour, found it dead, though placed in a cool spot‡."

It is thus evident that the life of the imago, in all the species, is a period of the most intense but brief excitement. When on the wing, Mr. Thwaites describes the *Stylopes* as "exceedingly graceful in their flight, taking long sweeps, as if carried along by a gentle breeze," usually flying high in the air, but "occasionally hovering at a few inches distant from the ground§." Mr. Dale also says of the specimen captured by himself, that "it flew with an undulatory and vacillating motion" amongst the young shoots of a quickset-hedge in his garden, and that he "could not catch it till it settled on one, when it ran up and down, its wings in motion, and making a considerable buzz or hum, nearly as loud as a *Sesia*||." These are precisely the habits we might expect to find in an insect that required to seek the object of its solicitude on the wing. But, further than this, Mr. Dale saw another *Stylops,* confined under a glass in the sun, with a bee, *Andrena labialis,* from which it had recently been developed, mount on the body of the bee, and remain seated on it, while the latter was in motion, and using every effort to rid itself of the parasite. Further, Dr. Siebold more recently has seen a male of *Xenos Rossii* mount on the abdomen of a stylopized wasp (*Pollistes gallica*), and, agitating its wings rapidly, endeavour with much ardour to introduce the extremity of its body between the segments of the body of the wasp, which doubtless contained the female *Xenos.*

It is fair to infer, then, that this is the mode in which the apodal female *Strepsiptera* are impregnated while still within the bodies of other insects, as believed by Dr. Siebold; and that to this great intent of creation every peculiarity of structure in the body of the male is to be referred; thus apparently showing, not only the dependence of function, but even also of special instinct, on peculiarities of structure. The great development of the organs of sense,

* Curtis's British Entom. fol. 226. † *Loc. cit.* fol. 433. ‡ *Loc. cit.* fol. 385.
§ Trans. Ent. Soc. Lond. vol. iii. part 1. || Curtis's British Entom. fol. 226.

the extreme activity of body, and the conscquent shortness of life in the male,—the invariable result of excessive action in organizcd beings,—all seem to have direct relation to this peculiarity of its matured instinct, while the great object of the existence of the cntire family of these insects, as a part of creation, seems to be conccntred in the parasitism of the larva.

Comparison of Meloë and Stylops.

Having traced the natural history of the *Strepsiptera* in connexion with their organization, we are now able to comparc the facts of both with those of *Meloë* and its affinities. Both *Meloë* and *Stylops*, at the moment of escape from thc egg, are hexapod insects, and both at that period attach themselves parasitically to other insects, *Hymenoptera*. The *Stylops* hatched within its parent, in the abdomen of the bee, issues forth and clings to the hairs which cover the body of the fated insect, and thus at once has a means of conveyance on the bee to her nest, in which it is to be fed. Thus provided at the instant of its birth with safe transport to its food, the *Stylops* scarcely requires the use of organs of consensual function, and, accordingly, we find that such organs, its antennæ, its eyes, are almost entirely absent, its limbs alone being those which are then needed for its purpose. The *Meloë*, destined also to be conveyed by the active bee to its nest, is hatched at the roots of herbaceous plants, in the earth, and quickly after its evolution from the egg, climbs the stems of the flowers of *Taraxacum* and *Ranunculus* to gain the interior of their calyces, where it awaits amongst the petals to attach itself to the unwary insect the instant she alights to collcct pollen for her young. But for the fulfilment of this great intent of nature, the young *Meloë* is not only furnished with powerful limbs, fitted to cling firmly to its victim, but also is endowed with amazing activity, and its consensual organs are extensively developed, more especially those of vision. Thcse organs are formed and perfectcd long before it leaves thc ovum; and, consequent on this carly maturity of structure, the function of these parts is extremely acute and instantaneous. Yet evcn in thesc the larval type of organization is still preserved. The eye, as in the true parasitic *Anoplura*, is still but a single ocellus, on each side of the head; and although most exquisitely sensible of light, is totally unfitted in its structure for distant vision, but is admirably adapted to the microscopic

examination of near objects, the function specially required for the peculiar habits of the animal.

When located in the cell, which the careful parent-bee closes in to protect her young,—unconscious of the danger she has herself introduced,—the parasites, *Meloë* and *Stylops*, are very similar in their earlier changes and habits. The *Stylops*, as we have seen, penetrates into the body of the bee-larva, feeds on its substance, loses its organs of locomotion, then become utterly useless to it, and there undergoes its transformations. The *Meloë*, I have now reason to believe, also attacks the larva, while its organs of locomotion, as in *Stylops*, gradually become atrophied, and towards the end of its larva-state (Tab. XIV. figs. 15, 16) preparatory to its assuming the condition of a nymph (figs. 17, 18), have almost disappeared, being then reduced to simple tubercles. But here the analogies between *Stylops* and *Meloë* cease. The organization and habits of the latter, in its perfect state, are widely different from those of the former. The changes which the structures in the larva of *Meloë* undergo are in some parts carried to a greater extent than in corresponding parts of *Stylops*, and to a less in others, and the habits of the perfect insect as a consequence are different. From a parasitical (figs. 4, 5) the *Meloë* becomes a vegetable feeder (figs. 1, 2). The structure of the organs of nutrition are gradually altered in form during the growth of the larva (figs. 8, 10*c*, 11); and when this has changed to the nymph, and afterwards to the imago state, the parts of its mouth are then adapted only for the prehension and comminution of vegetable food.

In my former memoir, some observations on a larva (fig. 34, *u*) that seemed to be the middle stage of growth of that of *Meloë*, and which also I had found in the nest of *Anthophora* (fig. 19), led me then to the conclusion that the young *Meloë* fed only on the food stored up for the bee-larva, and consequently, that its parasitism was on vegetable and not on animal matter*.

* Note on *Cryptophagus cellaris*. (Read April 6th, 1847.)

In my first memoir on *Meloë*, read to the Linnean Society on the 18th of November 1845, I mentioned a larva of some coleopterous insect of which I had found three specimens, in a cell that inclosed also a nymph of *Anthophora*, amidst others in the same bank of earth from which I obtained the full-grown larvæ of *Meloë cicatricosus*. The general appearance of this larva induced me then to think it highly probable that this was the young of *Meloë*, in a stage of growth more advanced than that in which *Meloë* is found parasitic on the winged insect; and that, from some cause or other,—deficiency of food, or lateness of period at which they were conveyed to the cell,—these specimens had not acquired

But a close examination of the structure of the mandibles of the young *Meloë*, and its habit of appearing to seize with them, and to thrust them into the soft parts of the tegument of the bee which it clings to, as at the junction

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their full growth before the bee-larva changed to a nymph. The general appearance of the head, antennæ and eyes in these larvæ, and the existence of what might readily be regarded as atrophied caudal styles, all conspired to lead to this view; while the form of their mandibles, and the circumstance of the larvæ being included in a cell in which a bee-larva had recently become a nymph, and, above all, that of their actually feeding on the rejectamenta voided by the young bee at its change, then led me further to think that the *Meloë* is parasitic on the food of the young bee, and not on the bee itself. But as at that time the specimens were still living, and had not undergone any change since they were taken in the preceding October, I did not describe them as actually the young of *Meloë*.

As I have now traced these larvæ to their imago state, it may be well to append a short notice of the species to my paper on *Meloë*, as of an insect which is occasionally found in the cell of *Anthophora*, the usual habitation of the larva of *Meloë cicatricosus*.

The *larvæ* (TAB. XIV. fig. 34, *u*) were nearly all of the same size, and each measured about one-third of an inch in length. They were fat, white, and very active, with the body formed of thirteen segments, besides the anal one, which was employed in locomotion as a pro-leg. Each segment was armed with a few elongated tufts of hairs. In the general form of the head and antennæ the larva resembled the early stage of *Meloë*. The antennæ were four-jointed, with the second joint the longest and somewhat clavate, and the third and fourth delicate and setaceous. The head was somewhat quadrate (fig. 35), wider than long, with a short transverse lip, and a small projecting ocellus at each of its anterior angles. The mandibles were short, thick, and a little acute at the apex, and resembled those of a vegetable-feeding larva; while the palpi were filiform and slightly elongated, and the labium was narrow and deeply emarginated. The prothorax was broad, rounded in front and dilated at its sides; and the meso- and metathoracic segments were soft, and did not present any difference in appearance from those of the abdomen. The legs were short, strong, scaly, and terminated in a single acute claw; and the præanal segment was armed with a pair of short horny styles.

I kept these larvæ in a small glass vessel, partially filled with dry clay, in the midst of which I placed them, in the cell of *Anthophora*, with the bee-nymph, which they did not attempt to injure, but usually concealed themselves beneath it, amidst the rejectamenta, on which, as I have stated, they fed. They very much resembled the larva of *Opilus mollis*, figured and described by my friend Mr. Waterhouse[1]; but on showing them to that gentleman, I found they were quite unknown to him. They seemed to prefer a very dry locality, as on moistening the soil with a few drops of water they were greatly inconvenienced. In the beginning of January 1846 each specimen had quitted the cell, and excavated for itself a little burrow in the clay, and on the 28th and 29th of January they changed to nymphs.

The *nymph* (fig. 36) closely resembled in appearance that of *Diaperis Boleti*. The first and second pairs of legs were flexed at right angles with the body, and the third pair diagonally, the extremity of the femoral joint projecting externally to the elytra. The anal and præanal segments were each

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[1] Trans. Ent. Soc. Lond. vol. i. pl. 6. fig. 1.

of the thorax with the abdomen, the articulations of the wings, and of the head with the thorax, &c., have led me now to a different opinion. The entire mouth seems quite unfitted to take the food that is stored up for the young bee, and it differs entirely from that of the bee itself. The mandibles are not short and broad organs, adapted for bruising the pollen, but are thin, falcated, sharp-pointed structures, admirably formed for piercing and cutting delicate tissues. A like structure of the mandible exists in the larva of *Lytta*, and also in that of *Sitaris*. In the larva *Meloë* the mandible is very slender, acute, and three-jointed (fig. 8), as in the inferior class *Myriapoda*, and nearly resembles that of *Cermatia* and *Lithobius*, most distinctly carnivorous genera, in which the part retains its original pedal form. But in *Sitaris*, as appears from the delineation given by Mr. Westwood, the mandible is not only acute and falcated, but is also toothed on its inner margin. *Sitaris*, like *Meloë*, we have seen is parasitic in the nests of *Anthophora*. Now this form of mandible rarely or ever exists except in carnivorous or parasitic insects, as in the truly carnivorous larvæ of *Dytiscus*, *Lampyris*, *Staphylinus*, *Coccinella*, *Sialis*, *Libellula*, and other predaceous genera. On the other hand, this form of mandible is never found in the true vegetable-feeding insects, or in their larvæ. In these the mandible is usually obtuse, and fitted for crushing and bruising; sometimes it is pointed at its apex and obtusely denticulated, but always it is short, broad, and very strong at its base. This, as we shall hereafter find, is the structure of the mandible in the perfect *Meloë* (fig. 9), which feeds entirely

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furnished with a pair of short articulated styles, and the sides of the abdomen, head and thorax with long hairs.

On the 25th of February two of these specimens had assumed the imago state, and the third was then in the act of doing so, and was throwing off its tegument. They were at first perfectly white, delicate, and unable to crawl. The antennæ, thorax and parts of the mouth quickly assumed a ferruginous hue, but the elytra and body continued white for two or three days. The strongest of the two specimens which had changed was greatly inconvenienced by exposure to light, and attempted to creep up the sides of the glass and escape from its influence, but was as yet too weak to do so.

The whole of the specimens remained in the burrows they had excavated in the dry clay until the 8th of March, when they came forth, and proved to be a species of the family *Engidæ*, *Cryptophagus cellaris* of Paykull.

It is worthy of remark, that the circumstance of these larvæ feeding on the rejectamenta of the young bee, voided at its change, invalidates a statement made by Mr. Westwood with regard to insects of this group, that they "never attack either living or dead animal matter[1]."

[1] Introduction to the Modern Classification of Insects, vol. i. p. 144.

on the leaves and flowers of the *Ranunculi* and the *Taraxacum*, devouring them in large quantities.

The conclusion, then, to which these facts seem to lead is, that the larva of *Meloë* is truly parasitical in its habits. Whether, like *Stylops*, it penetrates into the body of the young bee, or whether it preys on its substance through the wounded tegument, while the bee is nourished with its mixture of pollen and honey, is matter for future investigation. From the fact which I formerly stated, that the last skin which the *Meloë* larva throws off, before it has acquired the full-grown apodal state,—in which I have found it in the cells of *Anthophora*,—still retains the envelopes of the claws, and of very short tarsal, tibial and femoral joints, I am inclined to believe that it does not enter the body of the bee-larva: that in all probability it wounds it, and preys on its fluids from without. This kind of parasitism resembles that of *Scolia flavifrons* on the larva of *Oryctes nasicornis*, as recently so well shown by Signor Passerini *.

The anatomy of the young *Meloë* larva shows that its attack on the bee must take place at an early period; and either, that having destroyed the recently hatched bee-larva, its first tegument is cast, its mandibles are altered, and it then subsists on the food that had been stored up for the bee in the closed cell, and there gradually changes its form to that in which I have constantly found it (fig. 15); or that, like the larva of *Clerus*, having destroyed the bee in one cell, it penetrates into another and preys on the inhabitant, until it has attained its full growth, when it remains in one of these cells and undergoes its metamorphoses. The structure of the full-grown larva, the form of its head (fig. 10) immediately before it enters that state in which I have obtained it, the very altered form of its mandibles at that period, changed from the slender acute organs (fig. 8) it possessed at its birth, to thickened, short, corneous, obtuse jaws (fig. 11), fitted for bruising or comminuting its food, and its thickened, diminutive legs (fig. 14),—facts of its organization which I have ascertained by relaxing and unfolding the skin which it throws off on entering the apodal state,—all conspire to lead me to incline to the first of these views. This may explain the supposed anomaly in the habits of the species, of a sudden transi-

* Osservazioni sulle larve, ninfe, e abitudini della *Scolia flavifrons*, del Dott. Carlo Passerini. Pisa, 1840, 4to, pp. 15. Continuazione delle osservazioni nell' anno 1841 sulle larve di *Scolia flavifrons*. Firenze, 1841, 4to, pp. 7.

tion from a carnivorous to a truly vegetable-feeding insect, the transition itself being in reality gradual, like the change which takes place in the form of its manducatory organs. The manner in which the change in the structure of these parts is effected, and the slender, jointed, unguiculated, pediform organ of the young larva, fitted only for piercing and for prehension, is altered to the short, obtuse, and powerful jaw, is by the relative shortening, consolidation, and anchylosis of the coxal, femoral, and tibial divisions of the pediform mandible, whilst the long claw-like and acute apex is deciduated and entirely thrown off as a portion of the tegument at the next change of skin. This relative shortening is continued throughout the metamorphoses, and in this way the organ is gradually more and more altered in structure (fig. 9), is fitted for a new function, and is adapted for a complete change in the habits of the imago.

A general correspondence in structure thus seems to indicate similar correspondence in habit and function. Those families of insects which are most nearly allied in organization approach the most nearly to each other in their economy. But they differ from each other in the divergence of their particular habits or instincts from one general character, according as the structures which minister to those habits or instincts depart from the common type of formation. The larva of *Sitaris*, in the general conformation of its body, resembles that of *Meloë*, and both, as we have seen, are parasitic in their habits in the nests of the same genus of insects; but they differ in their special economy as well as in particular details of structure. All we yet know of the habits of *Horia* shows that this family also is parasitic in its larva state in the nests of the carpenter-bee. The perfect insect has long been known to be allied in general structure to the perfect *Meloë*, and I have little doubt that it approaches closely to that of *Meloë* and *Sitaris* in the early stage of its larva. The drawing given by the Rev. L. Guilding of the advanced stage of the larva of *Horia*, and the fact that Mr. Guilding's specimen has six short legs, so closely agree with the advanced stage of *Meloë*, that we may fairly regard the general form of the larva in the earlier stages of these two insects as similar, and conclude that *Horia*, *Sitaris* and *Meloë* all at first are parasitic on the bee-larva.

EXPLANATION OF THE PLATE.

TAB. XIV.

Fig. 1. *Meloë cicatricosus*, male:—natural size.

Fig. 2. *Meloë cicatricosus*, female:—natural size.

Fig. 3. The egg:—natural size.

Fig. 4. Larva of *Meloë violaceus* (natural size) soon after leaving the egg.

Fig. 5. The same, magnified. Fig. 6. The antenna. Fig. 7. Anterior leg. Fig. 8. Mandible of the larva articulated like that of the predaceous *Myriapoda*.

Fig. 9. Mandible of the perfect insect, *Meloë violaceus*.

Fig. 10. Form of the head of the matured larva of *Meloë cicatricosus* (magnified), as ascertained by examination of the cast exuviæ constantly found adhering to the full-grown or pseudo-larva (fig. 16) in the cell of *Anthophora retusa*. *a*. Antenna. *b*. The ocelli, three on each side, the anterior one the smallest. *c*. The mandible. *d*. The labrum.

Fig. 11. The mandible (magnified), seen on the under surface, as in fig. 9. *e*. The inferior articulation.

Fig. 12. Maxilla of the same, magnified. *f*. Maxillary palpus. *g*. Internal lobe of the maxilla.

Fig. 13. The labium, with its palpi.

Fig. 14. Leg of the matured larva of *Meloë*, as ascertained by an examination of the cast tegument:—magnified.

Fig. 15. The adult or pseudo-larva of *Meloë cicatricosus* (natural size), as found in the cell of *Anthophora*, with its organs of manducation and locomotion reduced to mere tubercles previous to their re-development in the nymph state.

Fig. 16. Highly magnified view of the head and legs of the same.

Fig. 17. The nymph or pupa of *Meloë cicatricosus* (natural size) inclosed in its cast pseudo-larva-skin, as constantly found in the cell of *Anthophora*.

Fig. 18. Inferior surface of the nymph, magnified 2 diameters, showing the large size of the head and organs of manducation.

Fig. 19. The imago *Meloë* in one of the cells of *Anthophora*, inclosed in its pseudo-larva-skin.

Fig. 20. Adult female of *Stylops aterrimus* vel *Melittæ*, highly magnified. A. Ventral surface of thorax. B. Abdomen. *a*. Mandible. *b*. Labial plates and mouth. *c*. The vulva, or outlet of the female organs. 1, 2, 3. The three thoracic segments united. *a*. The adult female:—natural size.

Fig. 21, 22. The larva of *Stylops* on the hair of *Andrena Trimmerana*, soon after birth:—magnified.

Fig. 23 to 32. The ovum in various stages of development. *a*. The yelk formed of cells. *b*. The blastodermic layer. *c*. Sulcus on the yelk. *d*. The blastoderma reflected on itself, and forming the ventral surface of the future embryo. *e*. The thorax, and entrance of the last portion of the yelk. *f*. The legs. *g*. The amnion.

Fig. 33. The male *Stylops aterrimus*:—highly magnified.

a. The same:—natural size.

Fig. 34. The larva of *Cryptophagus cellaris*:—magnified.

u. The same:—natural size.

Fig. 35. The head of ditto:—magnified.

Fig. 36. The nymph state:—magnified.